What is SCADA?

SCADA is not a specific technology, but a type of application. **SCADA** stands for Supervisory Control and Data Acquisition - any application that gets data about a system in order to control that system is a SCADA application.

A SCADA application has two elements:

1. The process/system/machinery you want to monitor a control - this can be a power plant, a water system, a network, a system of traffic lights, or anything else.

2. A network of intelligent devices that interfaces with the first system through sensors and control outputs. This network, which is the SCADA system, gives you the ability to measure and control specific elements of the first system.

it is not a full control system, but rather focuses on the supervisory level. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation.

NEED FOR SCADA

SCADA systems became popular in the 1960's as the need to monitor and control remote equipment grew. Early SCADA systems used mainframe technology and required human operators to make action decisions and maintain the information systems. Because this increased the human labor cost, early SCADA systems were very expensive to maintain. Today, SCADA is generally much more automated, and consequently more cost-efficient.

SCADA Hardware

A SCADA System consists of a number of Remote Terminal Units (or RTUs) collecting field data and sending that data back to a master station via a communications system. The master station displays the acquired data and also allows the operator to perform remote control tasks.

On a more complex SCADA system there are essentially five levels or hierarchies:

_ Field level instrumentation and control devices
_ Marshalling terminals and RTUs
_ Communications system
_ The master station(s)
_ The commercial data processing department computer system

Figure shows a typical SCADA system.

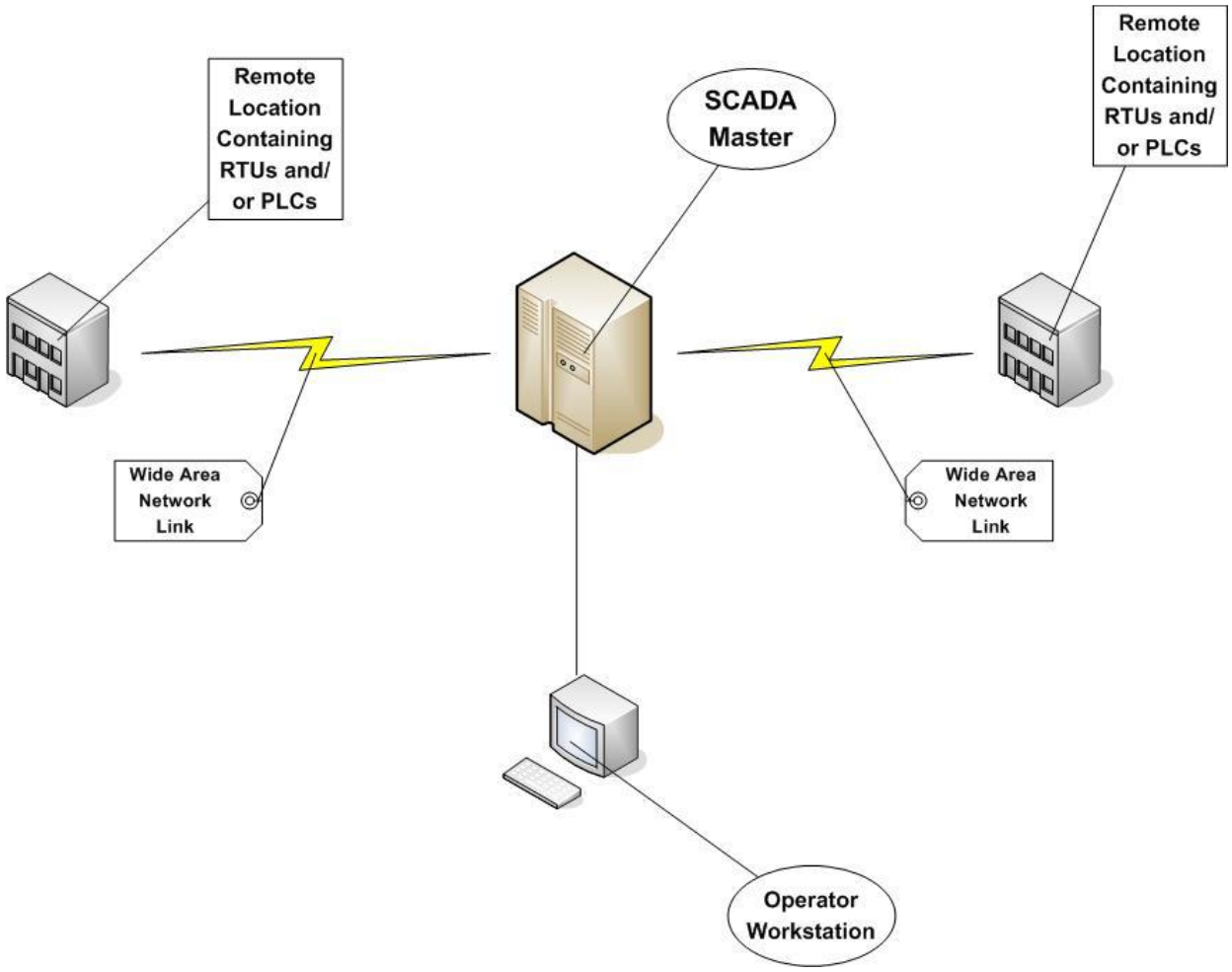

Fig. TYPICAL SCADA SYSTEM

SCADA Architectures

SCADA systems have evolved in parallel with the growth and sophistication of modern computing technology. The following sections will provide a description of the following three generations of SCADA systems:

• First Generation – Monolithic
• Second Generation – Distributed
• Third Generation – Networked

SCADA Software

SCADA Software can be divided into two types, Proprietary or Open. Companies develop proprietary software to communicate to their hardware. These systems are sold as "turn key" solutions. Open software systems have gained popularity because of the Interoperability they bring to the system.

Citect and WonderWare are just two of the open software packages available on the market for SCADA systems

SCADA and Local Area Networks

To enable all the nodes on the SCADA network to share information, they must be connected by some transmission medium. The method of connection is known as the network topology.

Nodes need to share this transmission medium in such a way as to allow all nodes access to the medium without disrupting an established sender.

Ethernet is the most widely used LAN today because it is cheap and easy to use.

Connection of the SCADA network to the LAN allows anyone within the company, with the right software and permission, to access the system. Since the data is held in a database the user can be limited to reading the information.

System Implementation

When first planning and designing a SCADA system, consideration should be given to integrating new SCADA systems into existing communication networks in order to avoid the substantial cost of setting up new infrastructure and communications facilities. This may be carried out through existing LANs, private telephone systems or existing radio systems used for mobile vehicle communications.

SCADA Systems Software

The typical components of a SCADA system, with emphasis on the SCADA software are indicated in the Figure 9.3.

Figure

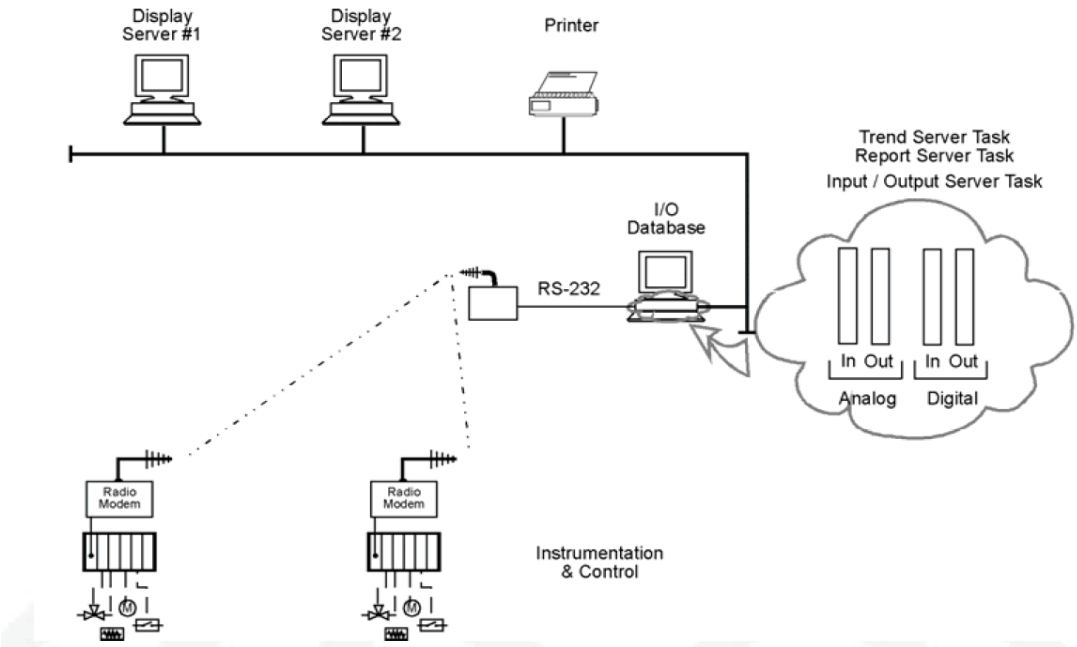

fig. COMPONENTS OF SCADA SYSTEM

SCADA Key Features

User Interface

_ Keyboard
_ Mouse
_ Trackball
_ Touch screen

Graphics Displays

_ Customer-configurable, object orientated and bit mapped
_ Unlimited number of pages
_ Resolution: up to 1280 x 1024 with millions of colors

Alarms

_ Client server architecture
_ Time stamped alarms to 1 millisecond precision (or better)
_ Single network Acknowledgment and control of alarms
_ Alarms shared to all clients
_ Alarms displayed in chronological order
_ Dynamic allocation of alarm pages
_ User-defined formats and colors
_ Up to four adjustable trip points for each analog alarm
_ Deviation and rate of change monitoring for analog alarms
_ Selective display of alarms by category (256 categories)
_ Historical alarm and event logging
_ Context-sensitive help
_ On-line alarm disable and threshold modification
_ Event-triggered alarms
_ Alarm-triggered reports
_ Operator comments that can be attached to alarms

Trends

_ Client server architecture
_ True trend printouts (not screen dumps)
_ Rubber band trend zooming
_ Export data to DBF, CSV files
_ X/Y plot capability
_ Event based trends
_ Pop-up trend display
_ Trend gridlines or profiles
_ Background trend graphics
_ Real-time multi-pen trending
_ Short and long term trend display
_ Length of data storage and frequency of monitoring that can be specified on a per-point basis
_ Archiving of historical trend data
_ On-line change of time-base without loss of data
_ On-line retrieval of archived historical trend data
_ Exact value and time that can be displayed

_ Trend data that can be graphically represented in real time

RTU (and PLC) Interface

_ All compatible protocols included as standard
_ DDE drivers supported
_ Interface also possible for RTUs, loop controllers, bar code readers and other equipment
_ Driver toolkit available
_ Operates on a demand basis instead of the conventional predefined scan method
_ Optimization of block data requests to PLCs
_ Rationalization of network user data requests
_ Maximization of PLC highway bandwidth

Scalability

Additional hardware can be added without replacing or modifying existing equipment. This is limited only by the PLC architecture (typically 300 to 40,000 points)

Access to Data

_ Direct, real-time access to data by any network user
_ Third-party access to real-time data, e.g. Lotus 123 and EXCEL
_ Network DDE
_ DDE compatibility: read, write and exec
_ DDE to all IO device points
_ Clipboard

Database

_ ODBC driver support
_ Direct SQL commands or high level reporting

Networking

_ Supports all NetBIOS compatible networks such as NetWare, LAN Manager, Windows for Workgroups, Windows NT (changed from existing NT)
_ Support protocols NetBEUI, IPX/SPX, TCP/IP and more
_ Centralized alarm, trend and report processing - data available from anywhere in the network
_ Dual networks for full LAN redundancy
_ No network configuration required (transparent)
_ May be enabled via single check box, no configuration
_ LAN licensing based on the number of users logged onto the network, not the number of nodes on the network
_ No file server required
_ Multi-user system, full communication between operators
_ RAS and WAN supported with high performance
_ PSTN dial up support

Fault Tolerance and Redundancy

_ Dual networks for full LAN redundancy
_ Redundancy that can be applied to specific hardware

_ Supports primary and secondary equipment configurations
_ Intelligent redundancy allows secondary equipment to contribute to processing load
_ Automatic changeover and recovery
_ Redundant writes to PLCs with no configuration
_ Mirrored disk I/O devices
_ Mirrored alarm servers
_ Mirrored trend servers
_ File server redundancy
_ No configuration required, may be enabled via single check box, no configuration

Client/Server Distributed Processing

_ Open architecture design
_ Real-time multitasking
_ Client/server fully supported with no user configuration
_ Distributed project updates (changes reflected across network)
_ Concurrent support of multiple display nodes
_ Access any tag from any node
_ Access any data (trend, alarm, report) from any node

The SCADA Software Package

Whilst performance and efficiency of the SCADA package with the current plant is important, the package should be easily upgradeable to handle future requirement. The system must be easily modifiable to allow for the requirements changing and expanding as the task grows - in other words the system must use a scaleable architecture.

There have been two main approaches to follow in designing the SCADA system:

_ Centralized, where a single computer or mainframe performs all plant monitoring and all plant data is stored on one database which resides on this computer.
_ Distributed, where the SCADA system is shared across several small computers (usually PCs).

An effective solution is to examine the type of data required for each task and then to structure the system appropriately. A client server approach also makes for a more effective system.

There are typically five tasks in any SCADA system. Each of these tasks performs its own separate processing.

_ Input/Output Task. This program is the interface between the control and monitoring system and the plant floor.
_ Alarm Task. This manages all alarms by detecting digital alarm points and comparing the values of analog alarm points to alarm thresholds.
_ Trends Task. The trends task collects data to be monitored over time.
_ Reports Task. Reports are produced from plant data. These reports can be periodic, event triggered or activated by the operator.
_ Display Task. This manages all data to be monitored by the operator

and all control actions requested by the operator.

How SCADA Systems Work

A **SCADA** system performs four functions:

1. Data acquisition

2. Networked data communication

3. Data presentation

4. Control

These functions are performed by four kinds of SCADA components:

1. **Sensors** (either digital or analog) and **control** relays that directly interface with the managed system.

2. **Remote telemetry units** (RTUs). These are small computerized units deployed in the field at specific sites and locations. RTUs (Remote Telemetry Units) serve as local collection points for gathering reports from sensors and delivering commands to control relays.

3. **SCADA master units**. These are larger computer consoles that serve as the central processor for the SCADA system. Master units provide a human interface to the system and automatically regulate the managed system in response to sensor inputs.

4. The **communications network** that connects the **SCADA** master unit to the RTUs in the field.

ADVANTAGES & DISADVANTAGES

The advantages of the PLC / DCS SCADA system are:
_ The computer can record and store a very large amount of data.
_ The data can be displayed in any way the user requires.
_ Thousands of sensors over a wide area can be connected to the system.
_ The operator can incorporate real data simulations into the system.
_ Many types of data can be collected from the RTUs.
_ The data can be viewed from anywhere, not just on site.

The disadvantages are:
_ The system is more complicated than the sensor to panel type.
_ Different operating skills are required, such as system analysts and programmer.
_ With thousands of sensors there is still a lot of wire to deal with.
_ The operator can see only as far as the PLC.
INDUSTRIAL APPLICATIONS OF SCADA

The potential applications of SCADA technology are diverse, because many industries require the comprehensive monitoring and control capabilities that SCADA offers. In most applications, SCADA is used to manage a physical process (manufacturing and water processing are common). In other uses of the word "SCADA", a telecom or IT system of communications is being managed instead.

Here are a few of the most common applications for SCADA systems:

Manufacturing
In manufacturing environments, SCADA is used to make sure that productivity targets are met and all systems run smoothly. The SCADA system in place on a production line tracks how many units have been produced and how many are in various stages of completion. Analog values like temperature at various production stages are also measured. Imagine how important it is to know the temperature of molten metal that must be formed into usable products.

Food Production
Very similar to manufacturing, food production is a major SCADA application. If temperature is important for equipment manufacturing, it is absolutely critical for the mass production of delicate foods. If temperature varies more than a few degrees, entire batches can fall out of acceptable specifications. This generates a lot of wasteful expense, which makes deployment of a SCADA system absolutely critical. The movement of liquid and solid ingredients and mixtures through the production process is also tracked by SCADA.

Electric and Gas Utilities
Utility companies, particularly gas utilities, suffer the combined headaches of manufacturing and telecom companies. They have to move a physical product (electricity isn't considered very physical, but it creates many more concerns than data transmission) through their systems, and they are spread out across gigantic territories. This makes utility environments a natural application for SCADA devices. They need to control the movement of electricity and gas through the distribution chain and also keep the supporting telecom infrastructure online.

Wastewater Treatment
The conversion of wastewater back into potable drinking water can really be thought of as another type of manufacturing process that delivers the world's most critical commodity. Flow rate sensors are extremely common in wastewater processing centers, as are contaminant sensors.

Telecom and Information Technology (IT)
Although not generally known as "SCADA" in telecommunications environments, a large number of professional do use this term to describe remote monitoring and control systems in these industries. Realistically, telecom is simply a near-instantaneous production environment, with bits of data instead of parts or food products. Monitoring temperature of servers and other delicate equipment is common when SCADA is used in this particular application. Monitoring the dedicated alarm contact closures of various equipment is also popular, as is monitoring

against physical intrusions into remote sites using magnetic door sensors and passive infrared (PIR) motion sensors.

New Technologies in SCADA Systems

A few of the new developments that are occurring in SCADA technology will be briefly listed below. The rapid advances in communications technology are an important driving force in the new SCADA system.

_ Rapid Improvement in LAN Technology for Master Stations
_ Man Machine Interface
_ Remote Terminal Units
_ Communications